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काँच इनेमल माण्ड के परीक्षण की पद्धतियाँ

भाग 2 परीक्षण पद्धतियाँ

अनुभाग 11 अपघर्षण के प्रति प्रतिरोधिता

(पहला पुनरीक्षण)

Indian Standard

METHODS OF TEST FOR VITREOUS ENAMELWARE

PART 2 TEST METHODS

Section 11 Resistance to Abrasion

(First Revision)

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BUREAU OF INDIAN STANDARDS
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NEW DELHI 110002

December 1995 **Price Group 3**

Ceramicware Sectional Committee, CHD 009

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Ceramicware Sectional Committee had been approved by the Chemical Division Council.

The Committee responsible for the formulation of this standard is given at Annex A.

This standard was first published in 1968. The committee, while reviewing IS 3972 : 1968 decided to publish this standard in two parts. Part 1 dealing with production of specimens for testing in two sections, namely, Section 1 Enamelled sheet steel, and Section 2 Enamelled cast iron. Part 2 will deal with various test methods applicable to vitreous enamelled sheet steel and vitreous enamelled cast iron. The committee also decided that Part 2 shall have various sections and each section will deal with a particular test method.

This standard (Part 2/Sec 11) prescribes the method for determination of resistance of vitreous enamelware to abrasion. The other sections of Part 2 are as follows :

Section 1	Resistance to citric acid at room temperature and boiling temperature
Section 2	Low and high voltage test for detection and locating defects
Section 3	Resistance to boiling water and water vapour
Section 4	Resistance to thermal shock
Section 5	Resistance to hot alkali (sodium hydroxide)
Section 6	Reflectance and specular gloss
Section 7	Resistance to boiling hydrochloric acid
Section 8	Resistance to heat
Section 9	Resistance to dilute sulphuric acid at room temperature
Section 10	Resistance to hot detergent solution used for washing textiles
Section 12	Resistance to torsion
Section 13	Resistance to warpage

This part (Part 2/Sec 11) of the standard prescribes the method for determination of resistance to abrasion, which is aligned with ISO/DIS 6370-1 'Vitreous and porcelain enamels — Determination of the resistance to abrasion — Part 1 : Abrasion testing apparatus' and ISO/DIS 6370-2 'Vitreous and porcelain enamels — Determination of the resistance to abrasion — Part 2 : Loss in mass after sub-surface abrasion'; issued by the International Organization for Standardization (ISO).

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

METHODS OF TEST FOR VITREOUS ENAMELWARE

PART 2 TEST METHODS

Section 11 Resistance to Abrasion

(First Revision)

1 SCOPE

This standard prescribes method of test for determination of resistance of vitreous enamelware to sub-surface abrasion.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
460 (Part 1) : 1985	Specification for test sieves : Part 1 Wire cloth test sieves (*third revision*)
1070 : 1992	Reagent grade, water (*third revision*)
2717 : 1979	Glossary of terms relating to vitreous enamelware and ceramic metal systems (*first revision*)
3972 (Part 1/Sec 1) : 1982	Method of test for vitreous enamelware: Part 1 Production of specimens for testing, Section 1 Enamelled sheet steel (*first revision*)

3 TERMINOLOGY

For the purpose of this standard, definitions given in IS 2717 : 1979 shall apply.

4 METHOD OF TEST

4.1 Principle

Mount three enamelled test specimens and three reference glass plates in the test apparatus. Simultaneous, expose the test specimens and reference plates to the abrasion attack of a moved mixture of fused aluminium oxide grains, steel balls and water for three periods of 30 min.

Calculate the relative amount of wear *W*, from the means of the measured absolute amounts of wear in mass for the three test specimens and for the three reference glass plates.

4.2 Apparatus

4.2.1 *Abrasion Testing Apparatus*

The abrasion testing apparatus is composed essentially from the parts specified in **4.2.1.1** to **4.2.1.4**.

4.2.1.1 *Oscillating table with drive*

This oscillating table of about 10 mm thickness, consisting of steel or light metal is placed horizontally on an eccentric drive in such a way that during the operation of the testing apparatus every point of the oscillating table describes a horizontal circle of (22 ± 1 mm) in diameter. The oscillating table shall be large enough so that at least three specimens to be tested and three standard glass plates can be clamped on it by aid of the retaining rings (*see* **4.2.1.2**).

The eccentric drive shall operate at a rotational frequency of 300±3 rpm and be provided with a device for checking the rotational frequency. The apparatus shall be firmly bolted to a concrete foundation or other rigid support.

4.2.1.2 *Retaining rings*

The dimensions of the retaining rings for inside height and diameter are shown in Fig. 2. The retaining ring shall be constructed of steel, cast iron or light metal lined with rubber. The opening serves for introducing the abrading charge and shall be capable of being closed by a stopper of rubber.

4.2.1.3 *Sealing rings*

To provide watertight seal between the retaining ring and the test specimen, sealing rings made of rubber shall be used at the lower edge of the retaining ring.

4.2.1.4 *Clamping devices*

Tightening of fasteners (wing-nuts) of the retaining ring shall press the retaining ring (**4.2.1.2**) with its lower edge against the sealing ring (**4.2.1.3**) which presses on its parts the specimen or the standard glass plate to the oscillating table. It shall be possible to loosen easily.

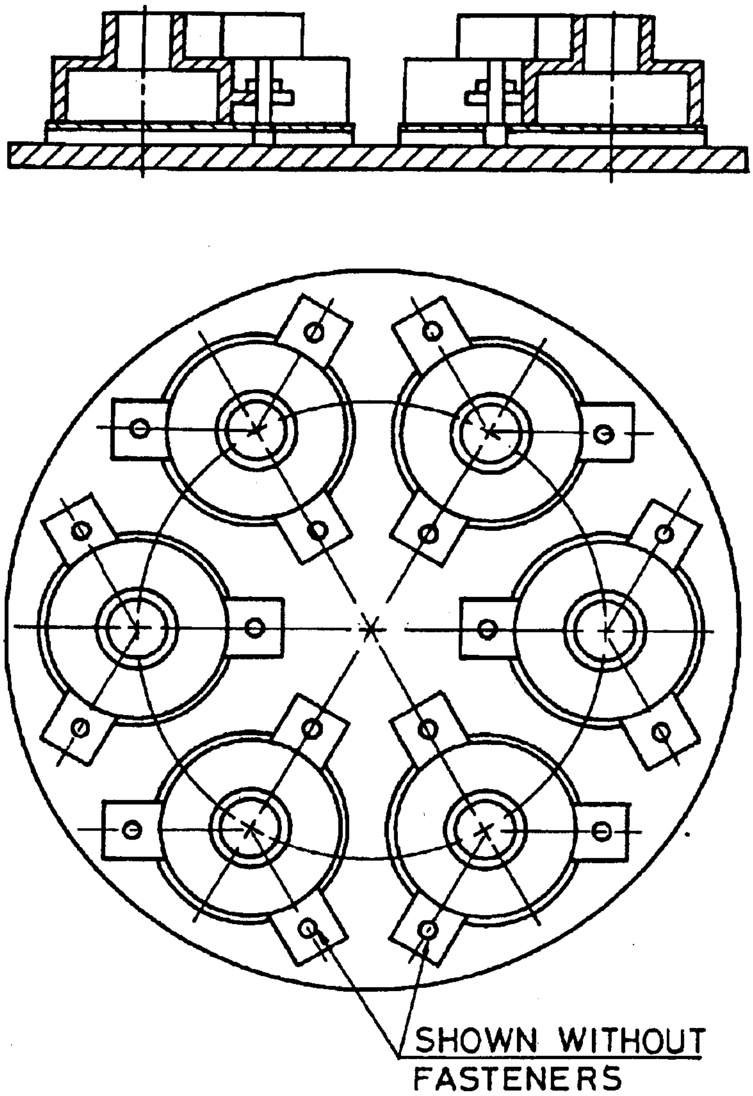


FIG. 1 ARRANGEMENT OF THE SPECIMEN AND STANDARD PLATES IN THE ABRASION TESTING APPARATUS

4.2.2 *Balance* — accurate to 0.2×10^{-3}g.

4.2.3 *Steel Balls*

For each test with a set of three specimens and three reference glass plates the following steel balls are required:

500 g balls of 4 mm diameter
400 g balls of 3 mm diameter
250 g balls of 2 mm diameter

4.2.4 *Abrasive*

Fused aluminium oxide of grain size passing from 70 micron to 1.00 mm sieve [*see* IS 460 (Part 1) : 1985].

4.2.5 *Reference Glass Plates*

Glass plates, with a side length of 100 mm, 3 mm thick, consisting of float glass having surface flatness commonly required to produce good glass mirror.

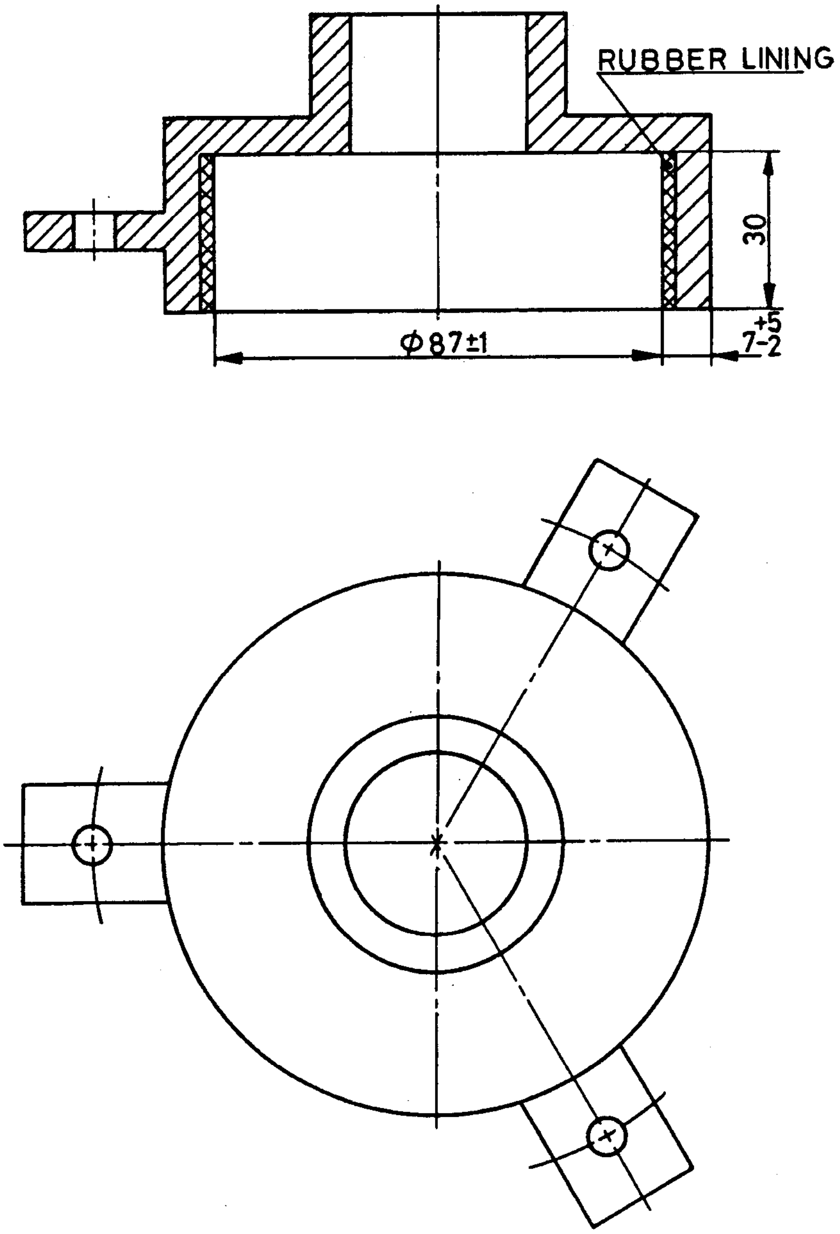
4.2.6 *Drying Oven* — capable of maintaining a temperature of at least 130°C.

4.2.7 *Desiccator*

4.3 Reagents

4.3.1 *Distilled Water — See* IS 1070 : 1992.

4.3.2 *Ethanol* — 96 percent to 98 percent (*v/v*).



All dimensions in millimetres.

FIG. 2 RETAINING RING

4.4 Test Specimens

Prepare the test specimens in accordance with IS 3872 (Part 1/Sec 1) : 1982. The test specimen should not exceed 200 g in mass.

4.5 Procedure

4.5.1 Rinse each test specimen and the reference glass plates with water and wipe it thoroughly with ethanol (**4.1**). Then dry the test specimens and the reference glass plates for 2 h in the drying oven (**4.2.6**) at 120 ± 5°C. Then allow them to stand for at least 2 h in the desiccator and finally weigh each to the nearest 0.2×10^{-3}g (starting mass).

4.5.2 Carry out one test with each set of at least three test specimens and three reference glass plates.

4.5.3 Fix the test specimens and the reference glass plates on the oscillating table of the abrasion testing apparatus (**5.1**) with aid of the retaining rings, sealing rings and clamping devices so that the cover coat sides of the test specimens and the float-bath surfaces of the reference glass plates.

4.5.4 Fill into each retaining ring the abrading charge and close it with the rubber stopper. The abrading charge consists of :

80 g balls of 4 mm diameter
60 g balls of 3 mm diameter
35 g balls of 2 mm diameter
(20 ±0.2 ml) water
(3±0.01 g) fused aluminium oxide grains (**4.2.4**)

The limiting deviations in weight for the balls: mass of each single ball.

4.5.5 Start the oscillating table of the abrasion testing apparatus for a period of 30±1 min corresponding to 9 000 ± 300 rotations. Then remove the specimens and reference glass plates, and rinse thoroughly the test specimens, the reference glass plates, the retaining rings and the sealing rings under running water. Dry the test specimens and reference glass plates in air and replace them on the abrasion testing apparatus together with a fresh abrading charge (**4.5.4**). The steel balls thoroughly cleaned may be used again.

4.5.6 If the thickness of the enamel coat to be tested is less than 0.2 mm it is recommended to weigh the test specimen before the next testing period. Start the oscillating table for a further period of 30 minutes and then repeat the whole procedure once more. If the vitreous enamel coat being tested is already removed or chipped-off, interrupt the test.

4.5.7 After three periods of 30 min remove the test specimens and the reference glass plates from the abrasion testing apparatus. Rinse them thoroughly with tap water and then with distilled water (**4.3.1**) and while still wet, rinse with ethanol (**4.3.2**). Dry the test specimens and the reference glass plates for 2 h in the drying oven (**4.2.6**) at 120±5°C and then allow them to stand for at least 2 hours in the desiccator (**4.2.7**) and finally weigh each to the nearest 0.2×10^{-3} g (final mass).

4.6 Calculation

Calculate for each test specimen and reference glass plate the loss in mass m in milligrams.

The relative amount of wear W, is calculated according to the equation:

$$W = \frac{\Delta mS1 + \Delta mS2 + \Delta mS3}{\Delta mR1 + \Delta mR2 + \Delta mR3}$$

where

$\Delta mS1, \Delta mS2, \Delta mS3$ is the loss in mass of the three test specimens S1, S2 and S3 tested, respectively; and

$\Delta mR1, \Delta mR2, \Delta mR3$ is the loss in mass of the three reference glass plates tested, respectively.

Furthermore calculate the quantities as well, for the test specimen tested as for the reference glass tested according to the equation:

$$M = \frac{\Delta m1 + \Delta m2 + \Delta m3}{\Delta m1^2 + \Delta m2^2 + \Delta m3^2 - \Delta m1\, \Delta m2 - \Delta m3\, \Delta m1}$$

The abrasion test carried out may be considered reliable, if for the specimens tested

$$S \geq 60$$

and for the reference glass plates tested

$$R \geq 60$$

If the quantities S and/or R are lower than 60, carry out a further test with new test specimens.

4.7 Test Report

The test report shall include the following information:

a) a reference to this Indian Standard;
b) a description of the test specimens;
c) the relative amount of wear W_r; and
d) in case of interruption, duration of the abrasion test.

ANNEX A

(*Foreword*)

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